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ABSTRACT We share 30 years of lessons learned about protecting and restoring Nachusa Grasslands in north-central Illinois. Land protection has required persistence. Volunteer stewardship has not only improved habitat but has also created a supportive human community for the project. Seasonally hired crews have proven to be an export product of our methods. Fire and weed management are carefully attended to. On planting prairie we specifically encourage you to plant a large amount of seed from many species, plant only the amount of land you have abundant seed to plant, try not to plant into areas with invasive weed problems, and invest in long-term science.

The Nature Conservancy's Nachusa Grasslands Preserve started in 1986 with the goal of purchasing tracts of land that had significant remnant habitats and then working to restore the farm fields surrounding these islands of remnant habitats to have a best possible conservation landscape. Our goals were to have high-diversity prairie, wetland and woodland restorations that would support rare species movements between remnants, and provide habitat for such species as regal fritillary butterflies (*Speyeria idalia*), prairie bushclover (*Lespedeza leptostachya*), kittentail (*Besseya bullii*), and other rare and uncommon species. After 30 years of land protection, the preserve is currently 3,600-acres, with over 120 prairie restorations. Volunteers have played a key role in managing the preserve, taking on prairie plantings, managing weeds, doing prescribed fire, leading tours, and many other tasks.

The preserve has a vigorous prescribed fire program that blends staff and volunteers. Bison (*Bison bison*) were introduced in 2014 with the goal of complementing the ecological driver of fire. The preserve has ramped up our science program 10-fold to attempt to record the changes that grazing, wallowing, dung, and hooves have on the habitats of Nachusa. We expect bison to reduce warm-season tallgrass abundance in our prairie plantings, increase abundance and diversity of prairie forbs, and open niche space for annual plants and some animals that want a more open structure. We have 90 bison with a dozen or two calves being born annually on 1,500-acres of mostly prairie plantings, with some remnant prairie and oak savanna.

Bill Kleiman, Nachusa Grasslands Preserve Manager, Ecologist Cody Considine, Nachusa's other staff members, and volunteers have learned a lot of lessons over 30 years by trial and error, careful monitoring, hosting annual open houses, and visiting many other preserves. What follows are the core lessons we have learned over 3 decades.

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Lesson: Persistence Pays in Purchasing Land

The Nature Conservancy worked steadily for 3 decades to assemble this 4,000-acre preserve, one tract at a time. Tracts with remnant habitat were pursued, with other tracts added to increase our size, connect remnants, and produce a preserve with defensible boundaries good for prescribed fire work, weed management, and hydrologic connections. Like assembling a complex puzzle, some tracts were purchased with the hope of being connected later. The largest tract purchased so far was 1,000 acres, and the smallest was 7 acres, with an average tract purchase size of 92 acres.

At times, we have purchased tracts with a checkered past, a mixture of wonderful remnant habitat with adjacent degraded remnants and ruderal areas full of weed trees and invasive legumes. One example of such a tract had the largest unplowed prairie left in the region at 60 acres, but it also had invasive birdsfoot trefoil (*Lotus corniculatus*) in about every foot of the prairie, leaving us with a high-maintenance situation. How do we control the invasive legume without damaging the remnant? For now, we are spraying the birdsfoot trefoil in the ruderal areas, and we also spray to keep the birdsfoot trefoil from our fire breaks and driving lanes so we don't move the seed around the preserve. We use Milestone herbicide for its residual control of emerging seedlings. It might be feasible to spot spray in the remnant, but for now it looks daunting and we have not sprayed there. This tract also had thousands of honey locust trees (*Gleditsia triacanthos*) that could survive the heavy cattle grazing with their branched long thorns. Many of those trees have now been removed. The tract also had 20 acres of dense autumn olive (*Elaeagnus umbellata*), which we mowed down and then seeded thick with prairie seed harvested with a combine. After 3 years, the autumn olive patch is about half prairie plants and half autumn olive. We hope annual fire and prairie can at least keep the autumn olive at bay. This tract also has an occurrence of a large and healthy ornate box turtle (*Terrapene ornate ornate*) population, oak woods with giant white (*Quercus alba*) and burr oaks (*Quercus macrocarpa*), and a small creek running along limestone outcrops. Overall, it was a great

Figure 1. Since the 1830s, wild bison were extirpated east of the Mississippi and reintroduced in Illinois for the first time on the Nachusa Grasslands in 2014. Photo by Charles Larry.

tract to protect but it is also an intensive management area that uses up valuable resources.

Lesson: Empower Volunteers to Get the Job Done

Nachusa has a core cadre of 2 dozen volunteer stewards who are leaders of tasks and managers of units. About half of our management units have a volunteer steward. Those stewards do some, or all, of the weed work on their units. They often overseed their units or harvest species to create new prairie plantings. The stewards support and mentor new volunteers and form the community of people that gives the preserve more energy than staff alone could. Volunteers find us through our website, Facebook page, tours, open houses, and trainings. For example, we met steward Mike Carr by knocking on doors next to a new tract we purchased. He was enthused that we purchased the tract and started coming out

Figure 2. A typical Nachusa lunch crowd of volunteers, researchers, and hired seasonal crew. Photo by TNC.

to workdays. In very little time, Mike was a steward of a management unit and a big part of our prescribed fire team. Being an electrician by trade, he has also saved us money by doing various electrical work.

Another example are Becky and Hank Hartman, who came out to a few tours of the preserve a long time ago, started volunteering, and since 2001 have been stewards who harvest up to 500 lbs. of seed annually. Many of our volunteers are empty nesters or students wanting to learn about environmental science—their ages range from Mike Adolph at 85 to Leah Kleiman at 17. Volunteers run our Saturday volunteer workdays, operate power equipment, apply herbicide, serve on our fire crew, coordinate our annual festival, lead our monthly tours, check our fences, lead school groups, pool donations to purchase utility vehicles, manage our website and Facebook page, mentor new volunteers, and make our break table talkative and fun. Volunteers attend meetings of resource experts and are looked to for answers. In short, volunteers are treated as colleagues.

Lesson: Hire Seasonal Crews

Our volunteers are important, but we would be sunk without the seasonal crews we have hired annually to go after weeds, harvest seed, and do many other tasks. Each season we hire college students or recent graduates and set them to work with careful leadership by our full-time staff, Bill Kleiman and Cody Considine. Often, we will assign one of the seasonal crew to be the crew boss. About half the preserve's work is accomplished with these seasonal hires and staff. We have on-site housing, which allows us to hire from far and wide. Our seasonal crews get a Nachusa experience that they carry forward into conservation careers.

Figure 3. Mike Carr, volunteer steward. Photo by Bill Kleiman.

For instance, Byron Forest Preserve has two of our alumni running their energetic natural areas program. Another alumnus is a regional steward for the Virginia Department of Conservation. During the summer, our break room is a busy hive of volunteers, scientists, and hired crew. The amount of effort being expended on this preserve is inspiring, or perhaps concerning, if you think that nature will take care of itself without human intervention.

Lesson: Implementing Prescribed Fire Takes a Focused Effort

Our fire return interval is under 2 years, with our best prairie remnants burned in portions for insect conservation. Our woodlands are burned annually where we have invasive shrub infestations. Restoring habitat requires more frequent fire because of our modern landscape of brush-choked habitats, fencerows of trees and shrubs, and a regional landscape generally devoid of fire. Our staff and volunteers work year-round to prepare for and do prescribed fire. We start each season with good fire breaks that are wide, mowed short, raked with hay rakes, and leaf blown with a tractor-mounted blower.

Our volunteers are trained with at least the wildfire courses of S-130/190, they have an annual safety refresher with live fire exercises, and we require an annual moderate pack test. We emphasize practice and preparation, working toward always being a safe and effective team that gets the fire job done. We burn a few thousand acres a year and produce an annual fire report.

We assist several conservation partners with their fire programs, offering crew and expertise as needed. Nachusa staff co-wrote the "Illinois Fire Needs Assessment," the first statewide accounting of how much fire we are doing across the state and how much more fire we need to be doing. The Assessment demonstrates that dramatically more acres need to be burned annually across Illinois.

Figure 4. Mike Miller with crew sweeping for weeds across large prairies looking for invasive weeds. Photo by Bill Kleiman.

Lesson: Weed Management Requires Sustained Effort, Priority Setting, and Good Strategies

Our crew and volunteers spend much of May, June, and July walking back and forth across prairies carrying backpacks of herbicide to spot spray or spades to dig out invasive plants. These weed sweeps are done at least once across all the prairies we have, with the most infested prairies getting multiple visits. Herbicide mixes are discussed, colleagues are questioned about what does and doesn't work, and encouragement is given to the Nachusa team to keep the worst weeds from going to seed. We spend the most time on legumes like sweet clover (*Melilotus officinalis*), birdsfoot trefoil, and red clover (*Trifolium pretense*); and, in the cooler months, we use basal bark herbicide to control invasive shrubs like bush honeysuckle (*Diervilla* spp.) and Russian olive (*Elaeagnus angustifolia*).

Lesson: Plant All Species on Year 1 That You Want on Year 100

An old theory in prairie restoration was to plant a "matrix" of rough and tough plants to make the soil ready for the more finicky plant species to be added years later. We have found that we can add all the species in year 1. A fine example is volunteer Jay Stacy, who planted seeds of 157 species of prairie plants into former cornfields. He did several adjacent plantings annually, each 5 to 7 acres in size. Fifteen years later, this restoration looks like a remnant prairie, with three species of violets, several upland sedges, blue-eyed grass, and other dainties. A visiting botanist would wonder how the old corn cobs got into the remnant prairie.

Figure 5. Mary and Al Meier in their 3-year-old prairie planting. Photo by Hank Hartman.

Lesson: Plant a Large Weight of Seed

From late spring until fall frost, our seasonal crew and volunteers annually hand harvest over 5,000 lbs. of seed from over 200 species. We now have more than 120 prairie plantings, mostly in retired corn and bean fields. It takes a lot of seed per acre to make sure an area fills in with native plants, and not weeds. We are planting 40 to 60 lbs. per acre of uncleaned seed, which includes the weight of chaff, stems, and pods. We run most of our harvested seed through a hammer mill, which is like a quiet leaf mulcher, shredding seed pods and seed heads and freeing the seeds. All that chaff and stems go with the seed into the mix. We use bulk seed harvest weights from previous years to set our target collection weights for each species. Our Kankakee Sands Preserve compared the average weights of uncleaned seed coming into their seed-cleaning shop with the weights of cleaned seed exiting and concluded that a third of the weight of uncleaned seed is the seed itself. So, our cleaned seed would be 14 to 20 lbs. per acre.

Lesson: Better to Have 5 Fabulous Acres Than a 50-Acre Weed Patch

Go slow enough to do it well. If you have enough seed to plant just 5 acres, then plant 5 acres. Keep the remainder in row crops or plant a monoculture of a grass that you can later kill with herbicide when you are ready to plant more prairie species. When registering with farm programs like Conservation Reserve Program and Wetlands Reserve Program, be careful to not sign up too many acres. A small but successful planting will have fewer problems and produce abundant seed for future plantings.

Figure 6. Dr. Holly Jones of Northern Illinois University measures a deer mouse (*Peromyscus maniculatus*) foot for her long-term study of small-mammal response to prairie revegetation and bison reintroduction. Photo by Steph Kong.

Lesson: Don't Plant into Areas with Weed Problems

Once you plant a prairie, there will always be follow-up weed work, so do not try to start with an established weed infestation. Invasive legumes like sweet clover and birdsfoot trefoil have seeds that are viable for decades. Farming the field a few years likely will not germinate all those weed seeds. You cannot plow the weed seeds deep enough. These legume weed seeds will steadily germinate over a few decades, and you must not let any plant grow to maturity and set seed. In some cases, we have planted these weedy areas with just grass species so that we can use a tractor to broadleaf spray the invasive weeds that will emerge over the years. This strategy saves our limited hand-weeding time for other areas and essentially leaves the next generation of stewards the job of making that ground diverse. When we find that we have mistakenly planted prairie into ground with lots of sweet clover, we do our best to hand treat each plant or mow patches when the plant is in full flower, but we always wish that we had planted some other field.

Lesson: Learn When to Start Over

Sometimes going backward is the best way to go forward. For a few former row-crop fields planted to prairie that had terrible establishment of prairie plants, we have put them back to row crops for several years and started over with a new prairie planting, typically seeded at a much higher rate and a much higher diversity. We would not do this with soil that has not been in row crops before. With ground never farmed, we would simply keep adding seed over the years and wait for plants to emerge and compete. Overseeding in this way does eventually yield results.

Lesson: Invest in Science

Whatever funding you have, focus your science efforts on the questions you need answered most. Nachusa has been supporting science since its start, but when we introduced our bison herd in 2014, we increased our science funding 10-fold to support long-term monitoring of grazing. We set up 22 grazing exclosure fences with 660 quadrats of floristic data among them. We also partnered with Northern Illinois University to do long-term research on beetles, small mammals, birds, soils, herps, and other taxa and work with Southern Illinois University on bison use of the preserve. Chicago Botanic Garden studies our rare prairie bushclover, whereas the University of Illinois studies our ornate box turtle. We hire private herpetologists to document the presence of our other herptiles. Volunteers monitor frogs, dragonflies, savanna birds, butterflies, and stream water quality. We also have expanded our science work on other aspects of natural-areas stewardship, hosting more than 24 permitted scientists at the preserve in the last few years. In 2008, a support group called Friends of Nachusa Grasslands began helping the preserve raise a stewardship endowment that recently surpassed a million dollars. The Friends group also funds science with The Nature Conservancy and has steadily increased their grants to researchers conducting studies at Nachusa, awarding $32,000 divided among a dozen recipients this year.

SUMMARY

Restoring diverse and dynamic habitat is hard work and to do this at a scale of several thousand acres is a gigantic undertaking. At Nachusa Grasslands, we have been at this task for 3 decades, and we will need to work hard for three times that. To do this right takes what Winston Churchill offered Britain at the start of World War II, “I have nothing to offer but blood, toil, tears, and sweat.” Let us share and learn as we go.